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Environmental Radioactivity Levels Bellefonte Nuclear Plant.(Annual)

Y 3.T25:52/
(date)

August 1985

ENVIRONMENTAL RADIOACTIVITY LEVELS
BELLEFONTE NUCLEAR PLANT
ANNUAL REPORT - 1984
TVA/NUC PR/RH

April 1985

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ENVIRONMENTAL RADIOACTIVITY LEVELS

BELLEFONTE NUCLEAR PLANT

ANNUAL REPORT

1984

Introduction

The Bellefonte Nuclear Plant (BLN), being constructed by the Tennessee Valley Authority, is located in Jackson County, Alabama, on a peninsula bounded on the west by Town Creek embayment and on the east by Guntersville Reservoir at Tennessee River Mile (TRM) 391.5 (see figure 1). The site is approximately 6 miles (10 kilometers) northeast of Scottsboro, Alabama. The plant will consist of two pressurized water reactors; each unit is rated at 3,620 MWt and 1,271 MWe. Fuel load in unit 1 is scheduled for no earlier than 1987.

A preoperational environmental radiological monitoring program was implemented in August 1978 and continued through 1983. This program had the objective of establishing a baseline of data on the distribution of natural and manmade radioactivity in the environment near the plant site. Because of the extended delay in fuel loading, the sampling program was substantially reduced in December 1983. This reduced program (see table 1) will continue until one year prior to fuel loading. At that time, the full preoperational sampling program will be restarted. This report presents the results obtained from the program conducted during 1984.

Radiological Health (Office of Nuclear Power) and the Office of Natural Resources and Economic Development carried out the sampling program outlined in table 1. Sampling locations are shown in figures 2, 3 and 4, and table 2 describes the locations of the environmental monitoring stations. All the radiochemical and instrumental analyses were conducted in TVA's Western Area Radiological Laboratory (WARL) located at Muscle Shoals, Alabama. Alpha and beta analyses were performed on Beckman Low Beta II, Beckman Wide Beta II, or a Tennelec LB5100. A Nuclear Data (ND) Model 6700 system in conjunction with germanium detection systems was used to analyze the samples for specific gamma-emitting radionuclides. Tritium determinations in groundwater are made with Packard Tri-Carb 3255 or 4000 series liquid scintillation counting systems.

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Data were entered in computer storage for processing specific to the analysis conducted. The data obtained by germanium detectors were resolved by the appropriate analyzer software and the software program routine HYPERMET.

The detection capabilities for environmental sample analysis given as the nominal lower limits of detection (LLD) are listed in table 3. All photopeaks found in germanium spectra were identified and quantified. Many of the isotopes identified by germanium spectral analysis are naturally occurring or naturally produced radioisotopes, such as ^{7}Be, ^{40}K, ^{212}Bi, ^{214}Bi, ^{212}Pb, ^{214}Pb, ^{226}Ra, etc. LLDs for additional radionuclides identified by germanium analysis were calculated for each analysis, and nominal values are listed in table 3. In the instance where an LLD has not been established, an LLD value of zero was assumed. An isotope may be identified and a valid result obtained and yet a mean and a range of 0 can be shown if the activity is between 0 and 0.01 since the output program displays results to two decimal places. A notation in a table of "$\overline{\ }$ values <LLD" for an isotope with no established LLD does not imply a value less than 0; rather, it indicates that the isotope was not identified in that specific group of samples. For each sample type, only the radionuclides for which values greater than the LLD were reported are listed in the data tables.

TVA's WARL participates in the Environmental Radioactivity Laboratory Intercomparison Studies Program conducted by EPA-Las Vegas. This program provides periodic cross-checks on samples of the type and radionuclide composition normally analyzed in an environmental monitoring program. Routine sample handling and analysis procedures were employed in the evaluation of these samples. The results received during calendar year 1984 are shown in table 4. The $\pm 3\sigma$ limits based on one measurement were divided by the square root of 3 to correct for triplicate determinations.

Table 5 contains a list of maximum permissible concentrations (10 CFR 20) for nonoccupational exposure for air and water for selected isotopes.

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Table 1

ENVIRONMENTAL RADIOACTIVITY SAMPLING SCHEDULE

BELLEFONTE NUCLEAR PLANT

Station Location	Vegetation	Soil	Well Water	Fish
Site SW	Q	A		
Site NE	Q	A		
Lim Rock (Control)	Q	A		
Rainsville (Control)	Q	A		
Onsite Wells (6)			Q	
Wheeler Reservoir				S[a]
Guntersville Reservoir				S[a]
Nickajack Reservoir (Control)				S[b]

Q - Quarterly S - Semiannually A - Annually

[a]Samples collected as a part of the Browns Ferry Nuclear Plant monitoring program.

[b]Samples collected as a part of the Sequoyah Nuclear Plant monitoring program.

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Table 2

ENVIRONMENTAL MONITORING STATION LOCATIONS
BELLEFONTE NUCLEAR PLANT

Sample Station	Approximate Distance From Plant	Approximate Direction From Plant
LM - 1 BL, Southwest	0.75 miles (1.2 kilometers)	SW
LM - 2 BL, Northeast	1 mile (1.6 kilometers)	NE
RM - 1 BL, Lim Rock, AL	18 miles (29 kilometers)	W
RM - 2 BL, Rainsville, AL	14.5 miles (23.4 kilometers)	SSE
Wells (1-6)	Onsite	
Nickajack Reservoir	26 miles (41.6 kilometers)	upstream
Guntersville Reservoir	Adjacent to plant	
Wheeler Reservoir	30 miles (48 kilometers)	downstream

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Table 3

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS

A. Specific Analyses

NOMINAL LOWER LIMIT OF DETECTION (LLD)*

	Air Particulates pCi/m³	Charcoal pCi/m³	Fallout mCi/Km²	Water pCi/l	Vegegation and Grain pCi/g, Dry	Soil and Sediment pCi/g, Dry	Fish Clam Flesh, Plankton, pCi/g, Dry	Clam Shells pCi/g, Dry	Foods, Meat, Poultry, pCi/Kgm, Wet	Milk pCi/l
Gross β	0.005			2.0	0.05	0.35	0.1	0.7		
Gross β	0.01		0.05	2.3	0.20	0.70	0.1	0.7	25	
^{3}H				330						
^{131}I		0.01								0.05
^{89}Sr	0.005			10	0.25	1.5	0.5	5.0	40	10
^{90}Sr	0.001			2	0.05	0.3	0.1	1.0	8	2

*All LLD values for isotopic separations are calculated by the method developed by Pasternack and Harley as described in HASL-300. Factors such as sample size, decay time, chemical yield, and counting efficiency may vary for a given sample; these variations may change the LLD value for the given sample. The assumption is made that all samples are analyzed within one week of the collection date. Conversion factors: 1 pCi = 3.7×10^{-2} Bq; 1 mCi = 3.7×10^{7} Bq.

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Table 3

DETECTION CAPABILITIES FOR ENVIRONMENTAL SAMPLE ANALYSIS

B. Gamma Analyses

NOMINAL LOWER LIMIT OF DETECTION (LLD)

	Air particulates pCi/m³		Water and milk pCi/l		Vegetation and grain pCi/g, dry		Soil and sediment pCi/g, dry		Fish pCi/g, dry		Clam flesh and plankton pCi/g, dry		Clam shells pCi/g, dry		Foods, (tomatoes potatoes, etc.) pCi/Kg, wet		Meat and poultry pCi/Kg, wet	
	NaI*	Ge(Li)**	NaI	Ge(Li)	NaI	Ge(Li)	NaI	Ge(Li)	NaI	Ge(Li)	NaI	Ge(Li)	NaI	Ge(Li)	NaI	Ge(Li)	NaI	Ge(Li)
^{141}Ce+^{144}Ce	0.03		38		0.55		0.35		0.35				0.35		38		90	
^{144}Ce		0.02		33		0.22		0.06		0.06		0.35		0.06		33		40
^{51}Cr	0.07	0.03	60	44	1.10	0.47	0.60	0.10	0.60	0.10		0.56	0.60	0.10	60	44	200	90
^{131}I	0.01	0.01	15	8	0.35	0.09	0.20	0.02	0.20	0.02		0.07	0.20	0.02	15	8	50	20
^{103}+^{106}Ru	0.04		40		0.65		0.45		0.45				0.45		40		150	
^{106}Ru		0.03		40		0.51		0.11		0.11		0.74		0.11		40		90
^{134}Cs	0.01	0.02	10	26	0.20	0.33	0.12	0.08	0.12	0.08		0.48	0.12	0.08	10	26	40	50
^{137}Cs	0.01	0.01	10	5	0.20	0.06	0.12	0.02	0.12	0.02		0.08	0.12	0.02	10	5	40	15
^{95}Zr-Nb	0.01		10		0.20		0.12		0.12				0.12		10		40	
^{95}Zr		0.01		10		0.11		0.03		0.03		0.15		0.03		10		20
^{95}Nb		0.01		5		0.05		0.01		0.01		0.07		0.01		5		15
^{58}Co	0.02	0.01	15	5	0.23	0.05	0.20	0.01	0.20	0.01		0.07	0.20	0.01	15	5	55	15
^{54}Mn	0.02	0.01	10	5	0.20	0.05	0.15	0.01	0.15	0.01		0.08	0.15	0.01	10	5	40	15
^{65}Zn	0.02	0.01	15	9	0.25	0.11	0.23	0.02	0.23	0.02		0.17	0.23	0.02	15	9	70	20
^{60}Co	0.01	0.01	10	5	0.17	0.06	0.11	0.01	0.11	0.01		0.08	0.11	0.01	10	5	30	15
^{40}K	0.10		150		2.50		0.90		0.90				0.90		150		400	
^{140}Ba-La	0.02		15		0.68		0.15		0.15				0.15		15		50	
^{140}Ba		0.02		25		0.34		0.07		0.07		0.30		0.07		25		50
^{140}La		0.01		7		0.08		0.02		0.02		0.10		0.02		7		15

*The NaI(Tl) LLD values are calculated by the method developed by Pasternack and Harley as described in HASL-300 and Nucl. Instr. Methods 91, 533-40 (1971). These LLD values are expected to vary depending on the activities of the components in the samples. These figures do not represent the LLD values achievable on a given sample. Water is counted in a 3.5-l Marinelli beaker. Vegetation, fish, soil, and sediment are counted in a 1-pint container as dry weight. The average dry weight is 120 grams for vegetation and 400-500 grams for soil sediment and fish. Meat and poultry are counted in a 1-pint container as dry weight, then corrected to wet weight using an average moisture content of 70%. Average dry weight is 250 grams. Air particulates are counted in a well crystal. The counting system consists of a multichannel analyzer and either a 4" x 4" solid or 4" x 5" well NaI(Tl) crystal. The counting time is 4000 seconds. All calculations are performed by the least-squares computer program ALPHA-M. The assumption is made that all samples are analyzed within one week of the collection date.

**The Ge(Li) LLD values are calculated by the method developed by Pasternack and Harley as described in HASL-300. These LLD values are expected to vary depending on the activities of the components in the samples. These figures do not represent the LLD values achievable on given samples. Water is counted in either a 0.5-L or 3.5-L Marinelli beaker. Solid samples, such as soil, sediment, and clam shells, are counted in a 0.5-L Marinelli beaker as dry weight. The average dry weight is 400-500 grams. Air filters and very small volume samples are counted in petri dishes centered on the detector endcap. The counting system consists of a ND-6620 multichannel analyzer and germanium detector having an efficiency of 20 percent. The counting time is normally 4-15 hours. All spectral analysis is performed using the software program HYPERMET. The assumption is made that all samples are analyzed within one week of the collection date.

Conversion factor: 1 pCi = 3.7×10^{-2} Bq.

TABLE 4

RESULTS OBTAINED IN INTERLABORATORY COMPARISON PROGRAM

A. Air Filter (pCi/Filter)

Date	Gross Alpha		Gross Beta		Strontium-90		Cesium-137	
	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.
11/83	19±9	41[a]	50±9	40[a]	15±3	16	21±9	20
3/84	15±9	18	51±9	60	21±3	20	11±9	10
8/84	17±9	17	51±9	60	18±3	N/A[b]	15±9	15

B. Tritum in Urine (pCi/l)

Date	EPA value (±3σ)	TVA Avg.
2/84	2383±608	2466
11/84	2017±598	2047

a. Sample fouled in preparation. Procedure modified to prevent recurrence.
b. Lost in analysis.

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TABLE 4 (Continued)

RESULTS OBTAINED IN INTERLABORATORY COMPARISON PROGRAM

C. Radiochemical Analysis of Water (pCi/l)

Date	Gross Alpha		Gross Beta		Strontium-89		Strontium-90		Tritium		Iodine-131	
	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.
1/84	10±9	10	12±9	15	36±9	39	24±3	23				
3/84	5±9	6	20±9	20								
4/84									3508±630	3580	6±0.8	6
5/84	3±9	4	6±9	6	25±9	32	5±3	5				
6/84									3081±622	2770		
7/84	6±9	6	13±9	16								
8/84									2817±617	2607	34±10	36
9/84	5±9	5	16±9	12	34±9	41	19±3	18				
10/84									2810±617	2517		
10/84[c]	14±9	11	64±9	60	11±9	12	12±3	13				
11/84	7±9	8	20±9	22								
12/84									3182±624	3400	36±10	33

D. Gamma-Spectral Analysis of Water (pCi/l)

Date	Chromium-51		Cobalt-60		Zinc-65		Ruthenium-106		Cesium-134		Cesium-137	
	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.	EPA value (±3σ)	TVA Avg.
2/84	40±9	<44	10±9	11	50±9	50	61±9	53	31±9	29	16±9	15
6/84	66±9	72	31±9	32	63±9	66	29±9	<40	47±9	44	37±9	37
10/84	40±9	43	20±9	22	147±9	151	47±9	48	31±9	29	24±9	26
10/84[c]			14±9	17					2±9	<5	14±9	16

c. Laboratory performance evaluation study

TABLE 4 (Continued)

RESULTS OBTAINED IN INTERLABORATORY COMPARISON PROGRAM

E. Foods (pCi/kg, Wet Weight)

Date	Strontium-89 EPA value (±3σ)	Strontium-89 TVA Avg.	Strontium-90 EPA value (±3σ)	Strontium-90 TVA Avg.	Iodine-131 EPA value (±3σ)	Iodine-131 TVA Avg.	Cesium-137 EPA value (±3σ)	Cesium-137 TVA Avg.	Potassium-40[d] EPA value (±3σ)	Potassium-40[d] TVA Avg.
1/84	34±9	40	20±3	19	20±10	20	20±9	21	2730±236	2670
7/84	25±9	N/A[e]	20±3	N/A[e]	39±10	40	25±9	26	2605±226	2624

F. Milk (pCi/l)

Date	Strontium-89 EPA value (±3σ)	Strontium-89 TVA Avg.	Strontium-90 EPA value (±3σ)	Strontium-90 TVA Avg.	Iodine-131 EPA value (±3σ)	Iodine-131 TVA Avg.	Cesium-137 EPA value (±3σ)	Cesium-137 TVA Avg.	Potassium-40[f] EPA value (±3σ)	Potassium-40[f] TVA Avg.
3/84					6±0.9	6				
6/84	25±9	24	17±3	18	43±10	39	35±9	34	1496±130	1483
10/84	22±9	26	16±3	15	42±10	40	32±9	30	1517±132	1563

d. Values reported as mg K/kg.
e. Lost in sample preparation.
f. Values reported as mg K/l.

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Table 5

MAXIMUM PERMISSIBLE CONCENTRATIONS

FOR NONOCCUPATIONAL EXPOSURE

	MPC	
	In Water pCi/l*	In Air pCi/m3*
Alpha	30	
Nonvolatile beta	3,000	100
Tritium	3,000,000	200,000
^{137}Cs	20,000	500
$^{103,106}Ru$	10,000	200
^{144}Ce	10,000	200
^{95}Zr-^{95}Nb	60,000	1,000
^{140}Ba-^{140}La	20,000	1,000
^{131}I	300	100
^{65}Zn	100,000	2,000
^{54}Mn	100,000	1,000
^{60}Co	30,000	300
^{89}Sr	3,000	300
^{90}Sr	300	30
^{51}Cr	2,000,000	80,000
^{134}Cs	9,000	400
^{58}Co	90,000	2,000
^{59}Fe	50,000	2,000

*1 pCi = 3.7×10^{-2} Bq.

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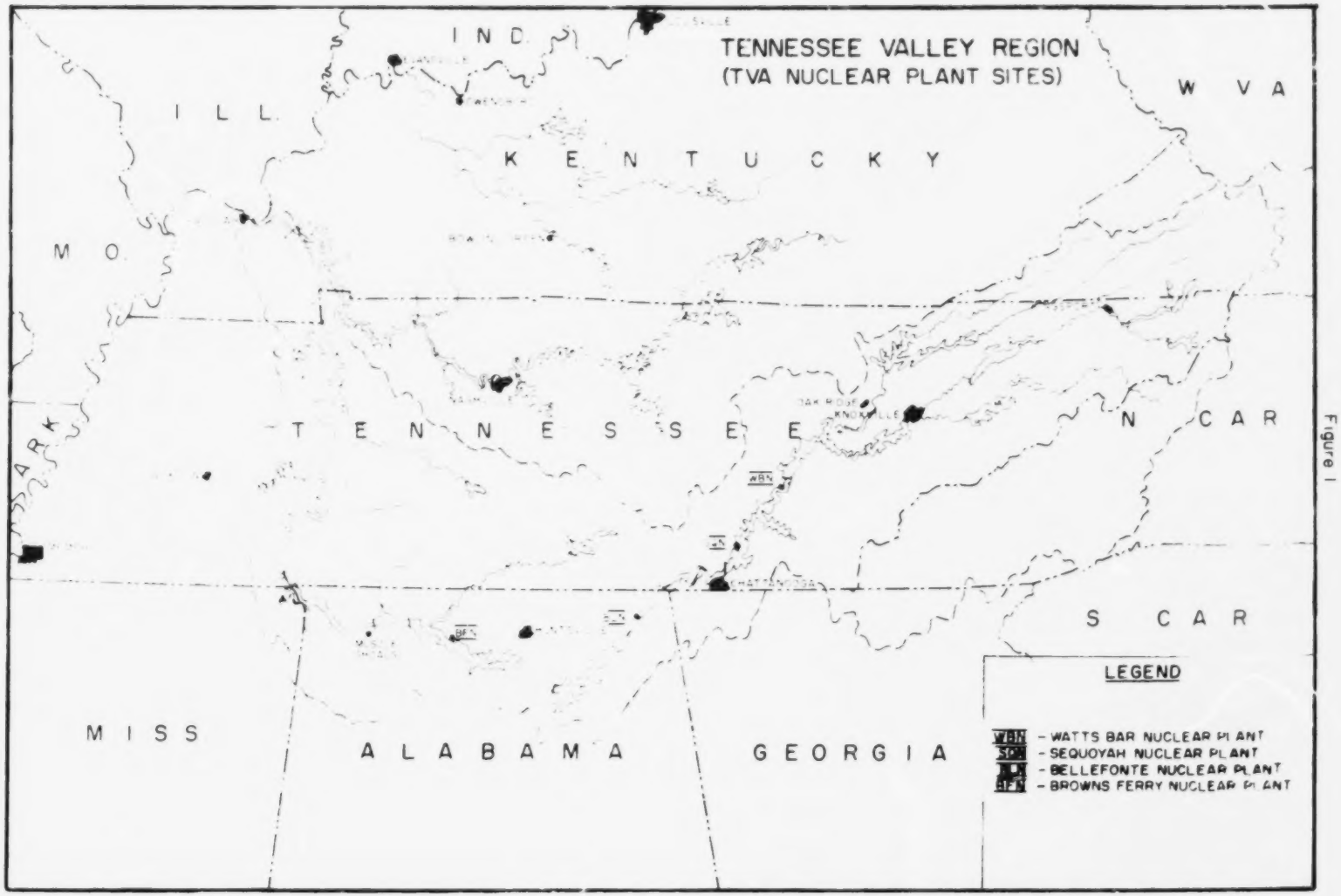

Figure 1

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Environmental Monitoring

The preoperational environmental radiological monitoring program for 1984 was significantly reduced from the program level of 1983. This modified program reflects decisions to slow construction at BLN and thereby extending the projected fuel loading until 1987 or beyond. Approximately one year prior to fuel loading, the full environmental sampling program will be restarted.

The interim reduced sampling program included collection of vegetation, soil, and groundwater. Environmental gamma radiation levels were determined by the use of thermoluminescent dosimeters (TLDs) placed at strategic locations in the environs. In addition, fish samples collected as part of the Sequoyah Nuclear Plant and Browns Ferry Nuclear Plant environmental radiological monitoring programs provided preoperational data from the Tennessee River in the vicinity of BLN. Figures 2, 3, and 4 show sampling and TLD locations.

Vegetation

Vegetation samples were collected quarterly from four locations and analyzed for gamma-emitting radionuclides. Approximately 1-2 kilograms of grass were broken or cut at ground level and returned for analysis. Efforts were made to sample vegetation that was representative of the pasturage where cattle graze. Table 6 summarizes the results obtained from the laboratory analyses.

Soil

Soil samples were collected annually at four locations to provide an indication of long-term buildup of radioactivity in the environment. An auger or "cookie cutter" type sampler was used to obtain samples of the top two inches (5 cm) of soil. These samples were analyzed for gamma-emitting radionuclides, ^{89}Sr, and ^{90}Sr. The results are given in table 7.

Groundwater

Well water was obtained quarterly from six onsite wells. All samples collected were analyzed for gamma-emitting radionuclides and for tritium. The results are shown in table 8.

Environmental Gamma Radiation Levels

Bulb-type Victoreen Manganese-activated calcium fluoride (CaF_2: Mn) thermoluminescent dosimeters (TLDs) are placed at 18 stations around the plant near the site boundary, at perimeter and remote locations, and at 18 additional stations approximately 5 miles from the site to determine the gamma exposure rates at these locations (see figures 2, 3, and 4). The dosimeters, located inside energy compensating shields, are placed at approximately one meter above the ground, with two to three TLDs at each station. They are annealed and read

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with a Victoreen Model 2810 TLD reader. The values are corrected for gamma response, self-irradiation, and fading, with individual gamma response calibrations and self-irradiation factors determined for each TLD. The TLDs are exchanged every three months. The quarterly gamma radiation levels determined from these TLDs are given in table 9. It should be noted that even during the preoperational phase of the monitoring program, the average radiation levels onsite are generally 3-4 mR/quarter higher than the levels offsite. This is consistent with levels reported in other preoperational monitoring programs conducted by TVA where the average radiation levels onsite are generally 2-6 mR/quarter higher than levels offsite. The causes of these differences have not been completely isolated; however, it is postulated that the differences are probably attributable to combinations of influences, such as natural variations in environmental radiation levels, earth moving activities onsite, the mass of concrete employed in the construction of the plant, and other undetermined influences.

Figure 5 compares plots of the data from the onsite or site boundary stations with those from the offsite stations over the period from 1978 through 1984. To reduce the variations present in the data sets, a four-quarter moving average was constructed for each set. Figure 6 presents a trend plot of the direct radiation levels as defined by the moving averages. The data follow the same general trend as the raw data, but the curves are smoothed considerably.

Fish

Radiological monitoring for fish is accomplished by analyses of composite samples of adult fish taken from each of three contiguous reservoirs--the reservoir on which the plant is located and the reservoirs immediately upstream and downstream. No permanent sampling stations are established within each reservoir; this reflects the movement of fish species within reservoirs as determined by TVA data from the Brown Ferry Nuclear Plant preoperational monitoring program. Sufficient fish are collected in each reservoir to yield 250-300 grams oven-dry material for analytical purposes. The composite samples contain approximately the same quantity of flesh from each fish. For each composite, a subsample of material is drawn for analysis.

Samples of white crappie and smallmouth buffalo are taken semiannually from Guntersville and Wheeler Reservoirs and analyzed for gamma-emitting radionuclides as a part of the BFN monitoring program. In the SQN monitoring program, samples of white crappie and smallmouth buffalo are taken semiannually from Nickajack Reservoir and analyzed for gross alpha, gross beta, gamma-emitting radionuclides, and strontium. Additional analyses were performed to determine gross beta and strontium in both species. The data from the analysis of all samples are summarized in tables 10, 11, and 12.

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TABLE 6

RADIOACTIVITY IN VEGETATION

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BELLEFONTE — DOCKET NO. 50-438/439
LOCATION OF FACILITY JACKSON ALABAMA — REPORTING PERIOD 1985

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b]	RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
IODINE-131	NOT ESTAB	0.00(5/ 8)	LM1 BL SOUTHWEST	0.00(3/ 4)		0.00(0/ 8)	
16		0.00- 0.00	0.8 MILE SW	0.00- 0.00		0.00- 0.00	
GAMMA (GELI)							
16							
K-40	NOT ESTAB	11.86(8/ 8)	LM1 BL SOUTHWEST	12.94(4/ 4)		11.84(8/ 8)	
		2.66- 18.48	0.8 MILE SW	5.41- 18.48		8.00- 14.84	
BI-214	0.100	0.13(1/ 8)	LM1 BL SOUTHWEST	0.13(1/ 4)		0.10(3/ 8)	
		0.13- 0.13	0.8 MILE SW	0.13- 0.13		0.10- 0.11	
BI-212	NOT ESTAB	0.27(1/ 8)	LM1 BL SOUTHWEST	0.27(1/ 4)		8 VALUES <LLD	
		0.27- 0.27	0.8 MILE SW	0.27- 0.27			
PB-214	NOT ESTAB	0.05(3/ 8)	LM1 BL SOUTHWEST	0.08(2/ 4)		0.10(7/ 8)	
		0.00- 0.12	0.8 MILE SW	0.04- 0.12		0.02- 0.21	
PB-212	NOT ESTAB	0.02(4/ 8)	LM1 BL SOUTHWEST	0.02(3/ 4)		0.04(4/ 8)	
		0.01- 0.03	0.8 MILE SW	0.01- 0.03		0.00- 0.07	
BE-7	NOT ESTAB	8.43(8/ 8)	LM1 BL SOUTHWEST	9.02(4/ 4)		7.43(8/ 8)	
		4.08- 13.11	0.8 MILE SW	4.08- 13.11		3.43- 21.75	
TL-208	NOT ESTAB	0.01(3/ 8)	LM1 BL SOUTHWEST	0.01(2/ 4)		0.01(3/ 8)	
		0.01- 0.01	0.8 MILE SW	0.01- 0.01		0.00- 0.02	
AC-228	NOT ESTAB	0.01(1/ 8)	LM2 BL ENV DATA	0.01(1/ 4)		0.11(3/ 8)	
		0.01- 0.01	1.0 MILE NE	0.01- 0.01		0.03- 0.18	

a. Nominal Lower Limit of Detection as described in table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

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TABLE 7

RADIOACTIVITY IN SOIL

PCI/G - C.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BELLEFONTE DOCKET NO. 50-438/439

LOCATION OF FACILITY JACKSON ALABAMA REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a]	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE[b]	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE[b]	CONTROL LOCATIONS MEAN (F)[b] RANGE[b]	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA (GELI) 4						
CS-137	0.020	0.41(2/ 2) 0.32- 0.50	LM1 BL SOUTHWEST 0.8 MILE SW	0.50(1/ 1) 0.50- 0.50	0.14(2/ 2) 0.06- 0.21	
K-40	0.200	5.12(2/ 2) 4.74- 5.50	LM1 BL SOUTHWEST 0.8 MILE SW	5.50(1/ 1) 5.50- 5.50	5.53(2/ 2) 5.53- 5.53	
BI-214	0.050	0.93(2/ 2) 0.92- 0.94	LM2 BL ENV DATA 1.0 MILE NE	0.94(1/ 1) 0.94- 0.94	0.59(2/ 2) 0.54- 0.63	
BI-212	0.100	1.26(2/ 2) 1.15- 1.37	LM1 BL SOUTHWEST 0.8 MILE SW	1.37(1/ 1) 1.37- 1.37	0.73(2/ 2) 0.74- 0.71	
PB-214	0.050	1.04(2/ 2) 1.02- 1.05	LM2 BL ENV DATA 1.0 MILE NE	1.05(1/ 1) 1.05- 1.05	0.66(2/ 2) 0.60- 0.72	
PB-212	NOT ESTAB	1.07(2/ 2) 1.02- 1.12	LM1 BL SOUTHWEST 0.8 MILE SW	1.12(1/ 1) 1.12- 1.12	0.59(2/ 2) 0.58- 0.61	
RA-226	0.050	0.93(2/ 2) 0.92- 0.94	LM2 BL ENV DATA 1.0 MILE NE	0.94(1/ 1) 0.94- 0.94	0.59(2/ 2) 0.54- 0.63	
RA-224	NOT ESTAB	1.28(2/ 2) 1.23- 1.33	LM1 BL SOUTHWEST 0.8 MILE SW	1.33(1/ 1) 1.33- 1.33	0.56(2/ 2) 0.45- 0.66	
TL-208	0.020	0.38(2/ 2) 0.36- 0.40	LM1 BL SOUTHWEST 0.8 MILE SW	0.40(1/ 1) 0.40- 0.40	0.20(2/ 2) 0.19- 0.20	
AC-228	0.060	1.10(2/ 2) 1.04- 1.17	LM1 BL SOUTHWEST 0.8 MILE SW	1.17(1/ 1) 1.17- 1.17	0.63(2/ 2) 0.59- 0.66	
PA-234M	NOT ESTAB	2.44(2/ 2) 2.41- 2.46	LM1 BL SOUTHWEST 0.8 MILE SW	2.46(1/ 1) 2.46- 2.46	2 VALUES <LLD	
SR 89	1.500	2 VALUES <LLD ANALYSIS PERFORMED 4			2 VALUES <LLD	
SR 90	0.300	2 VALUES <LLD ANALYSIS PERFORMED 4			2 VALUES <LLD	

a. Nominal Lower Limit of Detection (LLD) as described in table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

TABLE 8

RADIOACTIVITY IN WELL WATER

PCI/L - 0.037 BQ/L

NAME OF FACILITY BELLEFONTE — DOCKET NO. 50-438/439
LOCATION OF FACILITY JACKSON ALABAMA — REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a]	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE	CONTROL LOCATIONS MEAN (F)[b] RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GAMMA (GELI) 24						
K-40	NOT ESTAB	8.09(4/ 24)	WELL #6	15.65(1/ 4)		
		0.49- 15.65	ONSITE N	15.65- 15.65		
BI-214	NOT ESTAB	83.53(21/ 24)	WELL #4	253.58(3/ 4)		
		0.68- 455.74	ONSITE NNW	2.86- 455.74		
PB-214	NOT ESTAB	93.13(19/ 24)	WELL #4	199.15(4/ 4)		
		0.56- 456.00	ONSITE NNW	0.56- 456.00		
PB-212	NOT ESTAB	1.43(3/ 24)	WELL #5	3.25(3/ 4)		
		0.06- 4.02	ONSITE NNE	2.81- 4.02		
TL-208	NOT ESTAB	1.92(2/ 24)	WELL #4	2.31(1/ 4)		
		1.53- 2.31	ONSITE NNW	2.31- 2.31		
TRITIUM 24	330.000	24 VALUES <LLD ANALYSIS PERFORMED			0 VALUES <LLD	

a. Nominal Lower Limit of Detection (LLD) as described in table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

Table 9

ENVIRONMENTAL GAMMA RADIATION LEVELS

Average External Gamma Radiation Levels at Various Distances from Bellefonte Nuclear Plant for Each Quarter - 1984
mR/Quarter[a]

Distance Miles	Average External Gamma Radiation Levels[b]			
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
0-1	18.6±1.6	18.9±2.2	20.0±1.5	20.3±1.5
1-2	21.6±5.9	22.8±5.5	22.0±5.2	24.2±5.7
2-4	14.1±1.2	15.5±0.7	15.8±1.1	16.4±1.4
4-6	16.1±2.4	16.6±2.0	17.9±2.2	17.9±1.6
>6	14.7±1.1	15.7±1.6	15.9±1.8	16.2±1.7
Average, 0-2 miles (Onsite)	19.2±2.8	19.6±3.2	20.3±2.4	21.0±2.9
Average, >2 miles (Offsite)	15.4±2.1	16.1±1.7	17.1±2.2	17.2±1.7

[a]Data normalized to one quarter (2190 hours).

[b]All averages reported ±1 sigma (68 percent confidence level).

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TABLE 10

RADIOACTIVITY IN WHITE CRAPPIE (FLESH)

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BELLEFONTE DOCKET NO. [illegible]
LOCATION OF FACILITY JACKSON ALABAMA REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE	CONTROL LOCATIONS MEAN (F)[b] RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS ALPHA 2	0.100				0.16 (2/ 2) 0.11 - 0.21	
GROSS BETA 6	0.100	28.99 (4/ 4) 20.46 - 37.33	WHEELER RES TRM 275-349	29.09 (2/ 2) 25.19 - 32.98	32.25 (2/ 2) 23.88 - 40.62	
GAMMA (GELI) 6						
CS-137	0.040	0.08 (4/ 4) 0.07 - 0.11	GUNTERSVILLE RES TRM 349-425	0.09 (2/ 2) 0.07 - 0.11	0.07 (2/ 2) 0.07 - 0.08	
K-40	NOT ESTAB	15.21 (4/ 4) 11.72 - 17.51	WHEELER RES TRM 275-349	16.14 (2/ 2) 14.77 - 17.51	16.59 (2/ 2) 15.58 - 17.60	
BI-214	0.020	0.03 (2/ 4) 0.02 - 0.04	WHEELER RES TRM 275-349	0.04 (1/ 2) 0.04 - 0.04	0.28 (1/ 2) 0.28 - 0.28	
PB-214	NOT ESTAB	0.04 (2/ 4) 0.03 - 0.05	WHEELER RES TRM 275-349	0.05 (1/ 2) 0.05 - 0.05	0.14 (1/ 2) 0.14 - 0.14	
PB-212	NOT ESTAB	0.00 (2/ 4) 0.00 - 0.01	WHEELER RES TRM 275-349	0.01 (1/ 2) 0.01 - 0.01	2 VALUES <LLD	
SR 89 4	0.500	2 VALUES <LLD ANALYSIS PERFORMED			2 VALUES <LLD	
SR 90 4	0.100	2 VALUES <LLD			0.13 (1/ 2) 0.13 - 0.13	

a. Nominal Lower Limit of Detection (LLD) as described in table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

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TABLE 11

RADIOACTIVITY IN SMALLMOUTH BUFFALO (FLESH)

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BELLEFONTE — DOCKET NO. 50-438,439
LOCATION OF FACILITY JACKSON ALABAMA — REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE	CONTROL LOCATIONS MEAN (F)[b] RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS ALPHA 2	0.100				0.18(1/ 2) 0.18- 0.18	
GROSS BETA 6	0.100	26.35(4/ 4) 19.86- 39.18	WHEELER RES TRM 275-349	32.28(2/ 2) 25.39- 39.18	20.63(2/ 2) 20.45- 20.81	
GAMMA (GELI) 6						
CS-137	0.020	0.06(3/ 4) 0.04- 0.07	GUNTERSVILLE RES TRM 349-425	0.06(1/ 2) 0.06- 0.06	0.05(2/ 2) 0.04- 0.07	
K-40	NOT ESTAB	13.77(4/ 4) 9.34- 18.33	WHEELER RES TRM 275-349	15.44(2/ 2) 12.55- 18.33	13.26(2/ 2) 9.21- 17.32	
BI-214	0.020	0.04(1/ 4) 0.04- 0.04	WHEELER RES TRM 275-349	0.04(1/ 2) 0.04- 0.04	0.09(1/ 2) 0.09- 0.09	
PB-214	NOT ESTAB	0.02(4/ 4) 0.01- 0.04	WHEELER RES TRM 275-349	0.03(2/ 2) 0.02- 0.04	0.05(1/ 2) 0.05- 0.05	
PB-212	NOT ESTAB	0.01(3/ 4) 0.00- 0.01	WHEELER RES TRM 275-349	0.01(1/ 2) 0.01- 0.01	2 VALUES <LLD	
SR 89 5	0.500	3 VALUES <LLD ANALYSIS PERFORMED			2 VALUES <LLD	
SR 90 5	0.100	3 VALUES <LLD ANALYSIS PERFORMED			2 VALUES <LLD	

a. Nominal Lower Limit of Detection (LLD) as described in table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

TABLE 12

RADIOACTIVITY IN SMALLMOUTH BUFFALO (WHOLE)

PCI/G - 0.037 BQ/G (DRY WEIGHT)

NAME OF FACILITY BELLEFONTE DOCKET NO. 50-438,439
LOCATION OF FACILITY JACKSON ALABAMA REPORTING PERIOD 1984

TYPE AND TOTAL NUMBER OF ANALYSIS PERFORMED	LOWER LIMIT OF DETECTION[a] (LLD)	ALL INDICATOR LOCATIONS MEAN (F)[b] RANGE	LOCATION WITH HIGHEST ANNUAL MEAN NAME DISTANCE AND DIRECTION	MEAN (F)[b] RANGE	CONTROL LOCATIONS MEAN (F)[b] RANGE	NUMBER OF NONROUTINE REPORTED MEASUREMENTS
GROSS ALPHA 2	0.100				0.17(1/ 2) 0.17- 0.17	
GROSS BETA 6	0.100	16.65(4/ 4) 15.55- 18.29	WHEELER RES TRM 275-349	17.39(2/ 2) 16.49- 18.29	16.51(2/ 2) 12.83- 20.19	
GAMMA (GELI) 6						
CS-137	0.020	0.02(1/ 4) 0.02- 0.02	GUNTERSVILLE RES TRM 349-425	0.02(1/ 2) 0.02- 0.02	2 VALUES <LLD	
K-40	NOT ESTAB	7.54(4/ 4) 7.27- 7.68	GUNTERSVILLE RES TRM 349-425	7.61(2/ 2) 7.61- 7.62	7.30(2/ 2) 6.44- 8.15	
BI-214	0.020	0.04(2/ 4) 0.02- 0.05	GUNTERSVILLE RES TRM 349-425	0.05(1/ 2) 0.05- 0.05	0.04(2/ 2) 0.03- 0.04	
PB-214	NOT ESTAB	0.04(2/ 4) 0.04- 0.05	WHEELER RES TRM 275-349	0.05(1/ 2) 0.05- 0.05	0.06(2/ 2) 0.03- 0.09	
PB-212	NOT ESTAB	0.01(2/ 4) 0.01- 0.01	GUNTERSVILLE RES TRM 349-425	0.01(1/ 2) 0.01- 0.01	0.00(1/ 2) 0.00- 0.00	
SR 89 4	0.500	2 VALUES <LLD			0.73(1/ 2) 0.73- 0.73	
SR 90 4	0.100	0.23(1/ 2) 0.23- 0.23	GUNTERSVILLE RES TRM 349-425	0.23(1/ 1) 0.23- 0.23	0.18(1/ 2) 0.18- 0.18	

a. Nominal Lower Limit of Detection (LLD) as described in table 3.
b. Mean and range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

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Figure 2

BELLEFONTE NUCLEAR PLANT

MONITORING NETWORK

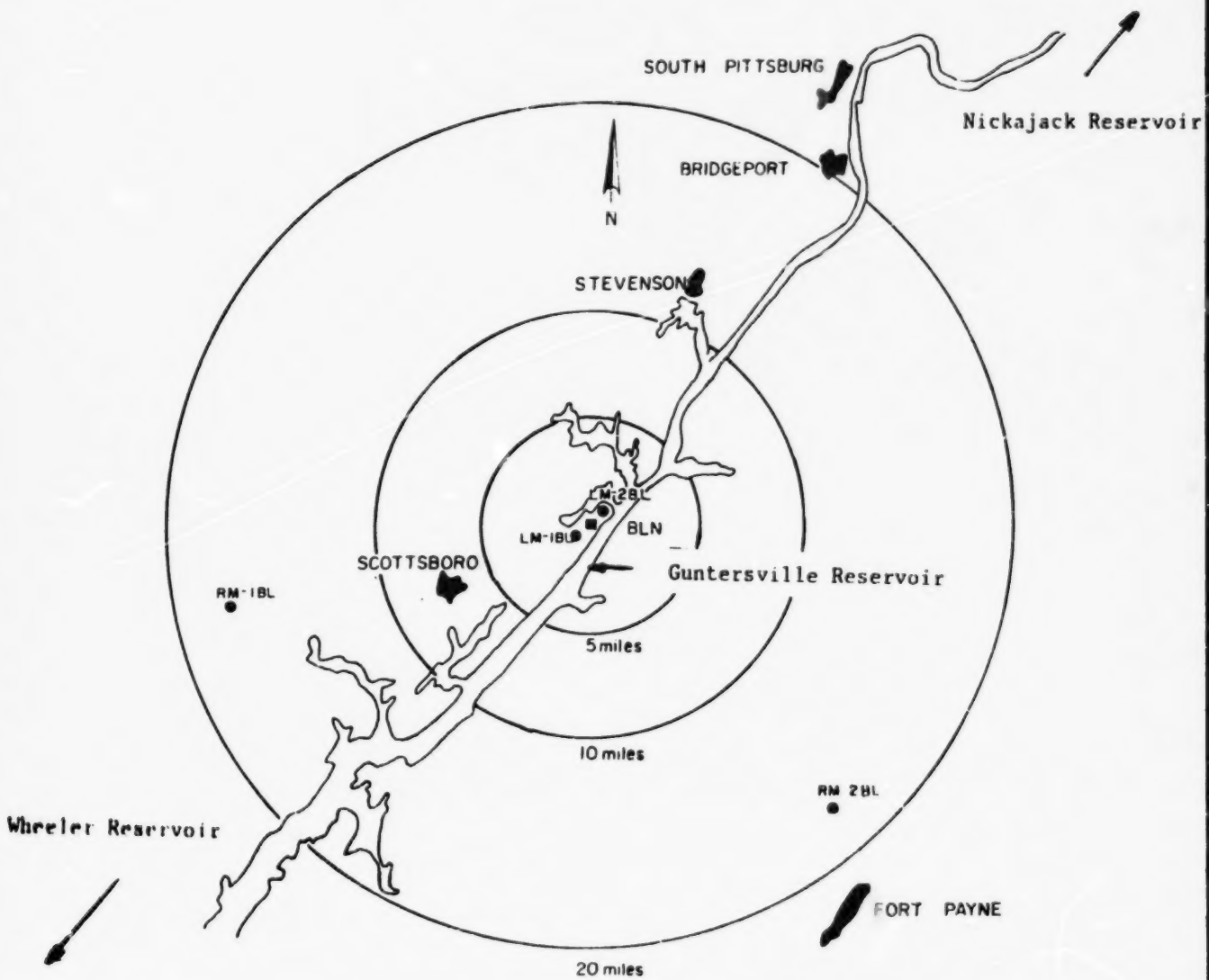

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Figure 3

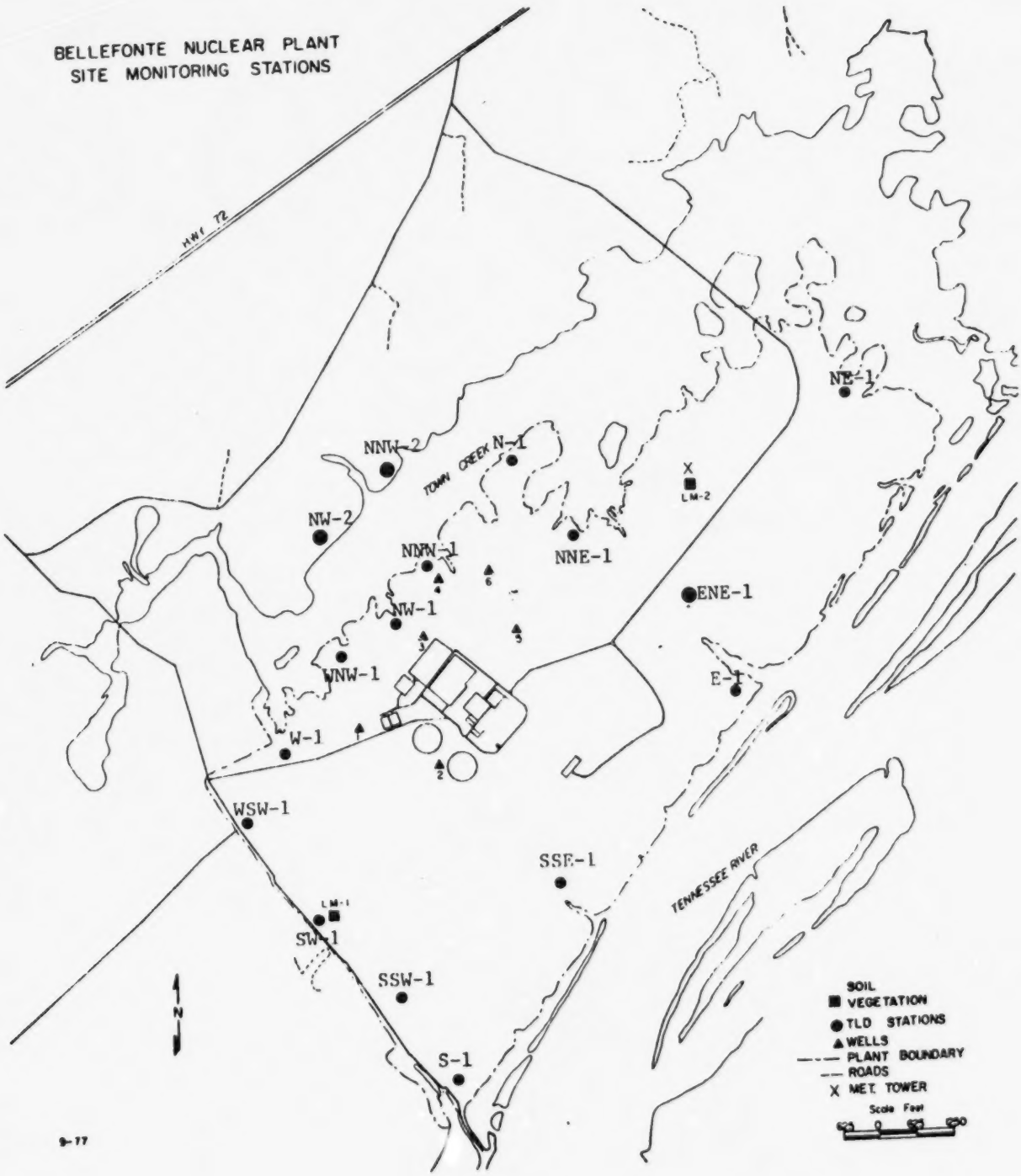

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Figure 4

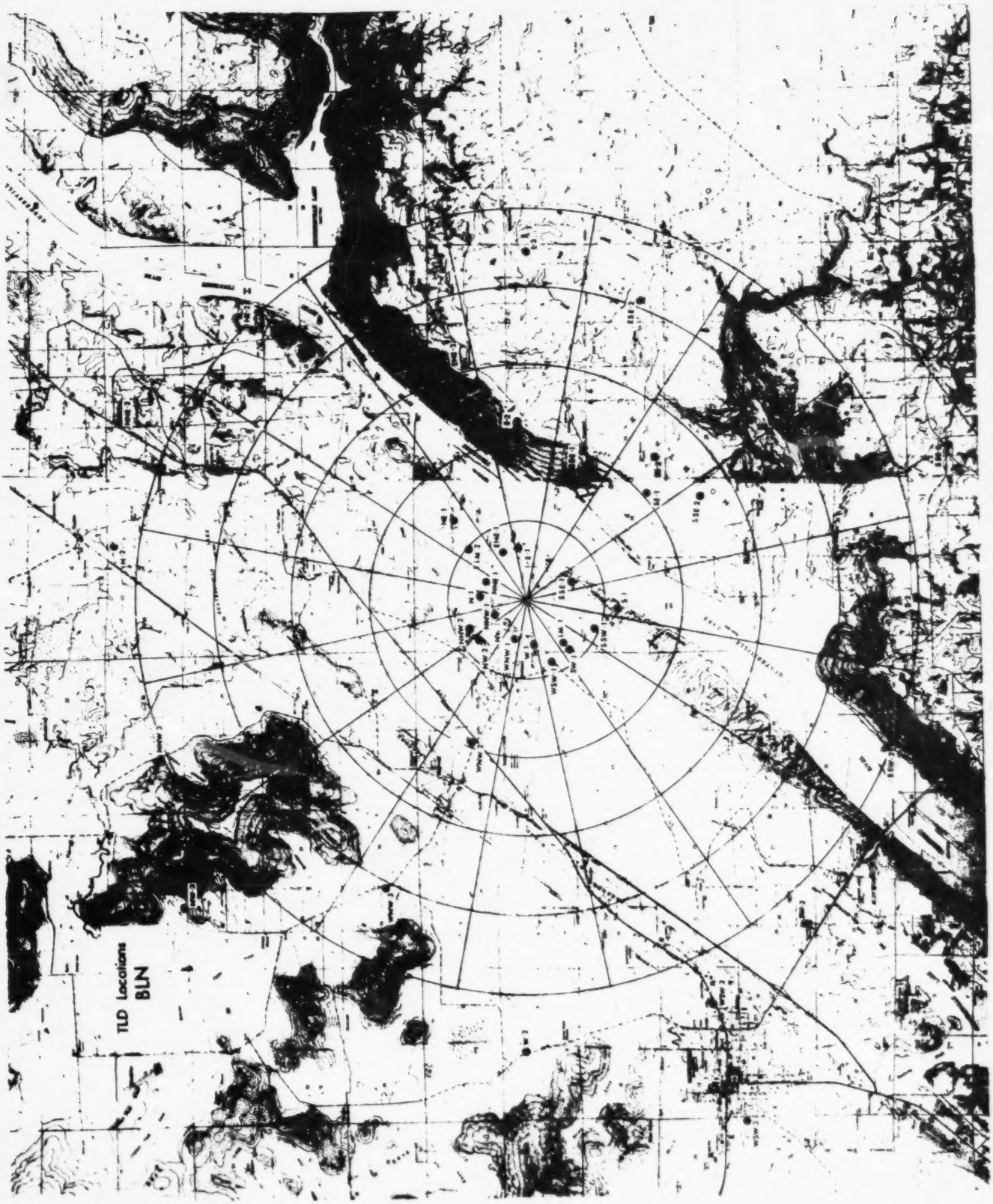

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Figure 5

Direct Radiation Levels
Bellefonte Nuclear Plant

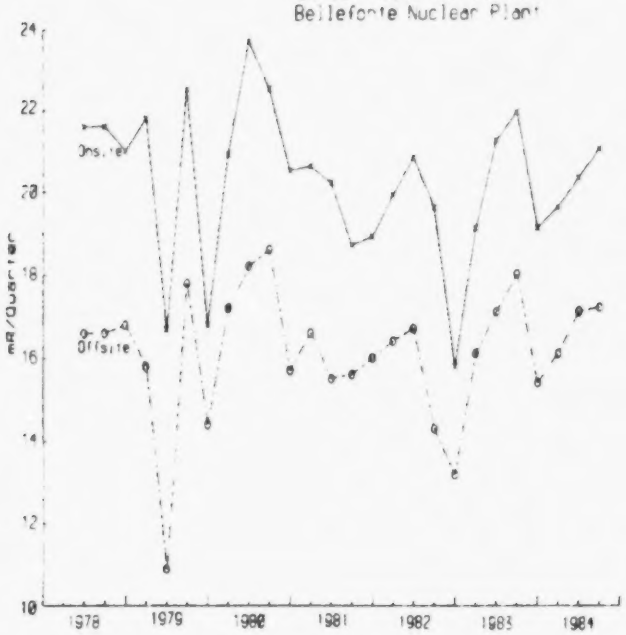
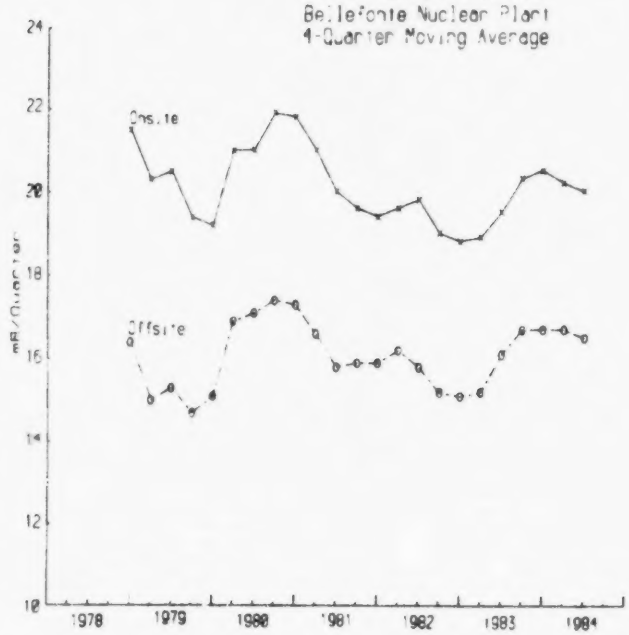


Figure 6

Direct Radiation Levels
Bellefonte Nuclear Plant
4-Quarter Moving Average



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Quality Control

A quality control program has been established with the Alabama Department of Public Health Radiological Laboratory and the Eastern Environmental Radiation Facility, Environmental Protection Agency, Montgomery, Alabama. Samples of air, water, milk, fish, and soil collected around nuclear plants are forwarded to these laboratories for analysis, and results are exchanged for comparison.

Conclusions

Since BLN has not achieved criticality, there has been no contribution of radioactivity to the environment from the operation of the plant. The levels of radioactivity being reported in this document are due to natural background radiation, fallout from nuclear weapons testing, or other nuclear operations in the area.

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